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REPORT ON CODLING-MOTH INVESTIGATIONS IN THE NORTHWEST DURING 1901.

BY

C. B. SIMPSON,

Investigator.

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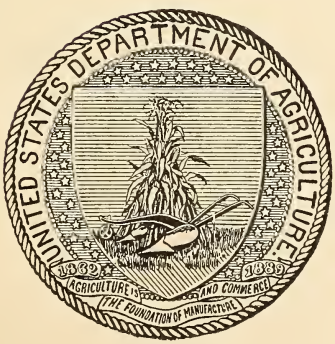

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1902.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Entomology,
Washington, D. C., May 19, 1902.

Sir: I have the honor to transmit herewith the manuscript of a report on the codling-moth investigation in the Northwest during 1901, conducted by Mr. C. B. Simpson, a special agent of this Division, and prepared by him for publication. Fruit growers in the Northwest, and especially in the States of Idaho, Washington, and Oregon, have complained that conditions in that part of the country must be very different from those which hold in the Eastern apple-growing sections, inasmuch as the remedial treatment which is found satisfactory in the East does not give equally good results in the Northwest. Therefore, under a special appropriation from Congress, some work was begun by this office in the late summer of 1900, Mr. Simpson being appointed to carry out the investigation and experiments. A report upon the work which he did in the season of 1900 was published in Bulletin 30 (new series) of this Office (pp. 51–63). In 1901 he was able to make a somewhat earlier start, and the results were therefore more satisfactory. This work is described in the accompanying bulletin. The present summer (1902) Mr. Simpson started for the field early in May, and it is hoped that at the close of the season the investigation will have arrived at such a point as to enable the publication of a full and satisfactory bulletin covering the whole problem. I recommend this bulletin to be published as No. 35 (new series).

Respectfully,

L. O. Howard,
Entomologist.

Hon. James Wilson,
Secretary of Agriculture.

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REPORT ON CODLING-MOTH INVESTIGATIONS IN THE NORTHWEST DURING 1901.

ITINERARY.

In accordance with the authorization of the Secretary of Agriculture and the instructions of the Entomologist, the following report is submitted upon the investigations of the codling moth in the Pacific Northwest for 1901.

I left Ithaca, N. Y., June 15, for Idaho, arriving at Salt Lake City, Utah, June 19. The Utah Agricultural College was visited and conferences were held with the authorities in regard to the codling moth. From Logan I went to Pocatello, Idaho, and thence to Market Lake, Idaho, to look over a grasshopper outbreak. At that place I found Professor Aldrich and with him looked over the infested section. A report of the results of this work has already been submitted. June 24 I left Market Lake and was accompanied by Professor Aldrich to Shoshone, Idaho, from which place I went to Shoshone Falls and Blue Lakes. Mr. Perrine's orchard at Blue Lakes was examined closely and remedial measures were advised. The 28th and 29th I spent in observing conditions about Mountainhome, arriving at Boise the 29th, where I spent a few days in looking over the orchards in that vicinity. A trip was then made to Nampa, Caldwell, Payette, and Weiser, Idaho, with return to Boise the 13th of July. Many trips were made to orchards about Boise. August 14 another trip was made, which included Nampa, Caldwell, Payette, Weiser and Emmett. Returning to Boise August 25, I remained there two days and then was in Mountainhome from the 27th to the 30th. In September several trips were made to Beatty, Nampa, and Meridian, and one to Payette.

October 4 I went to Portland, Oreg., for the purpose of attending the fruit fair and conferring with the Oregon people. I had a long talk with Professor Cordley and others of the Oregon Agricultural College and from there went to southern Oregon. From southern Oregon I returned to Portland and from there went to Moscow, Idaho. In company with the Entomologist and Professor Aldrich, I left Moscow October 18. After spending several days at Boise, I started for Washington, D. C., October 22 and arrived there on the 26th.

WORK DONE FROM ITHACA, N. Y.

Not being able to begin work in the field early enough to make observations during the blossoming period, circular letters were sent to prominent growers in Idaho asking them to conduct observations and begin experiments.

Letter No. 1 asked for observations in regard to the times of blooming, etc., and on life of the insect during that period. Several rendered valuable aid by making excellent observations.

Letter No. 2 asked several growers to begin cooperative experiments, which the writer would complete when he arrived upon the field. In every case the freeze of June 5 left no apples upon the trees which were selected for the experiments. Much work had been done by some growers in starting these tests.

Letter No. 3 was sent to 60 growers in different parts of the State asking that band records be kept. The fruit growers responded well to this request, and over 40 replies were received. Many valuable records were obtained.

TEACHERS' INSTITUTES.

During the summer the writer addressed four teachers' institutes upon the subject of the codling moth, the aggregate number of teachers present being about 180.

In each of these talks the damage caused by the insect and the importance of the subject were dwelt upon. A brief but fundamental sketch of the life history was given, fully illustrated by photographs and specimens of the insect's work. The most approved methods of control were explained and the results obtained by the same were given. The teachers were told how they might introduce the subject into their school work as a nature-study topic. Directions were given as to the method of presenting the work and collection of specimens. In these talks the writer took great pains to interest the teachers and has been rewarded by knowing that, in a great number of instances, the teachers put the suggestions into practice.

On account of the small fruit crop no summer meeting of the State horticultural society was held. Two farmers' meetings were addressed—one at Caldwell and another at Mountainhome. The attendance was poor, but the interest shown amply repaid the efforts exerted.

STATUS OF THE FRUIT CROP FOR 1901.

Early in the spring the fruit crop of 1901 promised to be large. A sudden freeze June 5, at which time apples were about the size of marbles, practically ruined all prospect for a good crop. About Boise prunes and peaches were all killed, and in some orchards no apples were left, while in others considerably over half a crop remained. In other sections conditions were about the same. Mr. McPherson esti-

mates that there was only about 10 per cent of an apple crop in Idaho in 1901, and his estimate is probably not far from correct.

On account of this short crop the price of apples was high and those who could save a large part of what crop they had made good profits.

INJURY DUE TO CODLING MOTH IN 1901.

On account of the small crop it is impossible to give an estimate that is of any value in regard to the damage by the insect in 1901. It was certainly much greater than in 1900.

In orchards with but little fruit the apples were all wormy, many of them containing from 5 to 10 holes. The writer counted the remains of 23 eggs on one apple and 17 on another.

The number of the insects was decreased but little by the freeze, while the number of fruits they had to work upon was greatly lessened. Consequently, in the orchards that were well cared for a large percentage of the fruits was wormy in spite of spraying and banding. The following are estimates of injury by the codling moth in individual orchards and in localities:

M. A. Kurtz, at Nampa, had over half a crop of apples. Many of them were undersized. Spraying and banding were well done. The loss for the whole orchard was about 20 per cent.

Mr. C. Hinze, Payette, had about half a crop of Jonathans. About 50 per cent was saved from this insect. Spraying alone was used.

Hon. Edgar Wilson had a small crop of Ben Davis and Jonathans. Early sprayings were made and bands were used. Less than 40 per cent of these were saved.

Mr. John McGlinchey had nearly a full crop at Payette. Early sprays were made but banding was neglected. Not over 20 per cent was saved.

Mr. Seth Heath, 9 miles from Mountainhome, thinks he saved 80 per cent of his apples and pears. Spraying and banding and other measures were used.

Mr. W. S. Whitehead, of Boise, saved only about 20 per cent by spraying and no banding.

Many orchards were noted in various localities where all the fruit was wormy.

Professor Aldrich has found that the damage in and about Moscow was about 5 per cent.

It was reported that about Walla Walla, Wash., and in the valley of the upper Columbia River the conditions were about as they were in the Boise Valley.

In the Willamette Valley the writer has been told that the injuries where no measures were used varied from 30 to 80 per cent.

In southern Oregon the writer found orchards near Central Point in which the injury did not exceed 5 per cent. In an untreated orchard 20 per cent of the apples were estimated to be damaged. Growers said that this orchard showed much less injury than many others in that locality.

FRUITS INFESTED BY THE CODLING MOTH.

The apple is by far the most subject to the attacks of this pest, and practically all of the work has been directed against the insect in this fruit.

In 1900 it was noted that some varieties of apples were more subject

to the attacks of this moth than others, and a list was prepared in order of injury. In 1901 but little revision of the list was necessary.

The following is the revised list:

Pewaukee (always badly infested).
Red Astrakan.
Bellflower varieties.
Spitzenberg.
Grimes Golden, Northern Spy, Gravenstein.
Wealthy.
Baldwin.
Ben Davis (very variable).
Rome Beauty (variable).
Jonathan.
Winesap (always least infested).

This list was made from observations in many orchards and is a composite of the conditions in these orchards. Local conditions are to a great extent the cause of the variability.

Pears are but little infested when compared with apples. In the very worst localities the injury sustained rarely if ever reaches 20 per cent, and, when remedial measures are used, injury varies from 5 to 15 per cent.

Many quinces were examined, but not a single case of infestation was noted.

Having in mind Professor Bruner's observations when he found larvæ which he took to be those of the codling moth feeding in seed pods of roses, the writer examined hundreds of these pods without finding any larvæ or eggs.

It has often been reported that the codling moth larvæ were attacking peaches, prunes, and plums. Upon investigation it was found in every case that the attack was made by the larva of the peach-twig borer.

INTRODUCTION AND SPREAD OF THE CODLING MOTH IN THE NORTHWEST.

Dr. C. V. Riley, in his Sixth Missouri Report (1874), mentions this insect as working in Utah, where it had evidently been introduced a year or two previous.

The Scientific American of November 14, 1882, mentions that the codling moth made its appearance in California in 1874.

Prof. J. M. Aldrich states that this insect has been known in the Clearwater Valley since 1887, and in southern Idaho nearly as long. By many orchardists in southern Idaho the writer was told that the above date is approximately correct. Many stories are told of how the insect reached Idaho, one being to the effect that the insect was introduced in dried prunes. Without doubt the insect was introduced in apples shipped either from Utah, Oregon, or Washington. When

once introduced it can be readily understood how the insect spread over the apple-growing area by the shipping of fruit from one section to another. The spread is found to be along the lines of transportation. It was retarded in a great measure by the fact that many orchards were isolated. A well-marked case of immunity resulting from isolation is shown in the case of Mr. Perrine's orchard at Blue Lakes. This orchard was free from the insect until two or three years ago, and is now but little infested. Mr. Perrine thinks the moth was introduced into his orchard in old boxes. The spread from orchard to orchard by the flight of the moths has been comparatively slow, and usually follows a river valley.

LIFE ZONES AND PRESENT DISTRIBUTION.

The status of the insect has been studied as far as the data at hand would permit. The life zones found in Idaho (fig. 1.) may be described as follows:

The Boreal zone comprises that part of the State known as the Panhandle, a strip along the northeastern side of the State and a large area in the central part of the State which is connected with the eastern strip.

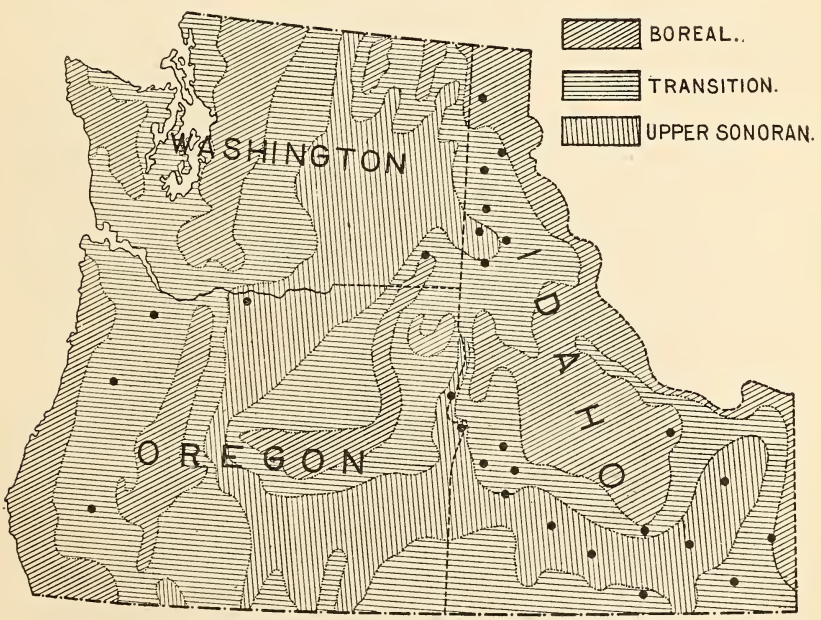


FIG. 1.—Map of the Pacific Northwest, showing life zones—locaities infested by codling moth indicated by dots.

The Transition zone is limited to an irregular area in the north and a fringe around the Boreal in the south. The southwestern and southeastern parts of the State are also in this zone. The Transition area in the northern part of the State is somewhat different from that of the southern part, on account of the larger amount of rainfall.

The Upper Sonoran comprises the area about the Snake River Valley. This area is continuous with the same zone in Oregon on the west and Utah on the south. An arm extends down the Snake River Valley on the western border. A small area of this zone is present in the valleys of the Snake and Clearwater rivers at Lewiston. At this point several of the Lower Sonoran fruits are grown.

The relations of the codling moth to these zones are as follows:

Boreal.—As no apples can be grown in this zone, this insect does not occur.

Transition.—The insect occurs in this zone, but is never greatly injurious. At Moscow the injuries for the past three years have been 21, 10, and 5 per cent, respectively. Many fruit growers have told the writer that the insect has its ups and downs, varying from practically no injury to 25 per cent. Correspondents at Almo, Cassia County; Lakeview, Laclede, and Rathdrum, Kootenai County; and Paris, Bear Lake County, state that they can find no indications of the insect at those places. The observations of those in the best position to know indicate that these locations are not well fitted for the growing of apples. The northern part of this zone, however, is evidently more suitable for apples than the southern part.

The Upper Sonoran.—From 80 to 90 per cent of the fruit raised in Idaho is grown in this zone. Some varieties of apples reach perfection. The codling moth reaches its maximum of numbers and destructiveness in this zone, and here the greater part of the investigation has been made.

LIFE HISTORY OF THE CODLING MOTH.

Many important variations in the life history of this insect were noted in 1901.

THE EGG.

As in 1900, many eggs were observed. In orchards where there were but few apples eggs were found in enormous numbers. On one apple the number of eggs or remains of eggs was found to be 23 (Pl. I, *D*); on another 17. It was difficult to ascertain the time of hatching of the eggs, but the times of hatching of eight were found with reasonable accuracy. These hatched in from three to eight days, with an average of about five days.

THE LARVA.

In a day or so after the egg is laid, a horseshoe-shaped band, which is the embryonic larva, may be seen. Later the form of the larva may be easily distinguished. In about five days the fully formed larva breaks its way through the shell and immediately seeks to enter an apple. The writer has many times attempted to observe the hatching of an egg and the entering of the apple, but has failed, although a few times the attempt was almost successful. The young larva of the first generation has been observed to spend some time upon the fruit and then to enter the calyx by squeezing its way in between the calyx lobes.

In 1900 the earlier countings showed that about 60 per cent entered the calyx end. Without doubt this low percentage was caused by

including the early individuals of the second generation. In 1901, by numerous countings, the average was found to be 83 per cent, with a minimum of 79 per cent. In one counting of 130 apples, 106 had entered the calyx and 24 the side. About half of those that entered by the side entered where the apples touched. In 12 apples there were two worms each. Three larvæ were killed by fungi or bacteria. Of those which had left the apples, 13 had left by the calyx and 17 by the side.

By far the larger number of the larvæ of the later generation enter the apple at other places than the calyx—in some cases, from 90 to 100 per cent. They enter at the sides (Pl. I), at the stem, and particularly where the apples touch. In badly infested orchards it is a rare exception to find apples which touch without finding also the entrance place of a codling-moth larva.

A few larvæ of the second generation were taken out of their burrows a few hours after they had entered and were placed upon apples in order to see what they would do. All immediately commenced searching for a place to enter. They would try to bite through the smooth skin, but their jaws would make but little impression. One of them entered at the stem, another found a broken place in the skin, and another succeeded in piercing the smooth skin. As has been noted by other observers, I found that the larvæ while entering eat but little, if any, of the skin or flesh of the fruit, but push the particles out behind them. They seem intent upon getting away from the light. Professor Cordley states that he has seen them spin silk over the mouths of the holes as soon as they have fully entered.

A few authors have advanced the opinion that those larvæ which hatch on the leaves eat sparingly of the leaves before they find the apples. In spite of many attempts to throw light upon this point, the writer can offer no evidence; but he believes that many perish on account of this habit, as they get any poison that may be on the leaves. In the field a large majority of newly hatched larvæ never reach an apple, but perish. This was especially true in 1901 on account of the scarcity of apples. The apples which had 23 and 17 eggs had only 5 and 4 worm holes, respectively.

When entering by way of the calyx, the larva eats its first few meals at the surface before commencing its burrow into the fruit. On entering at the side, the larva eats out a circular mine immediately under the skin, which can be easily distinguished by its lighter color. In about three to five days the larva, after making its burrow funnel-shaped, starts toward the central portion of the fruit. When the calyx is entered a large amount of castings is thrown out (Pl. I, *D*), but when the side is entered but a small amount is thrown out (Pl. I, *A*, *B*, *C*). When the central portion of the fruit is reached the larva eats out an irregular cavity which is found filled with pellets of excre-

ment bound together with silk. Data as to how long it takes the larva to become full grown were secured. However, the number of experiments and the number of larvæ were small and more work must be done before a good average can be given. The shortest time was fourteen days and the longest twenty-five, with twenty-one days as an average. When the larva is full grown it eats its way to the outside of the apple, but remains within, plugging the hole with frass. In a day or so this obstruction is pushed out, and the larva crawls out and immediately seeks a place in which to spin its cocoon and complete its transformation.

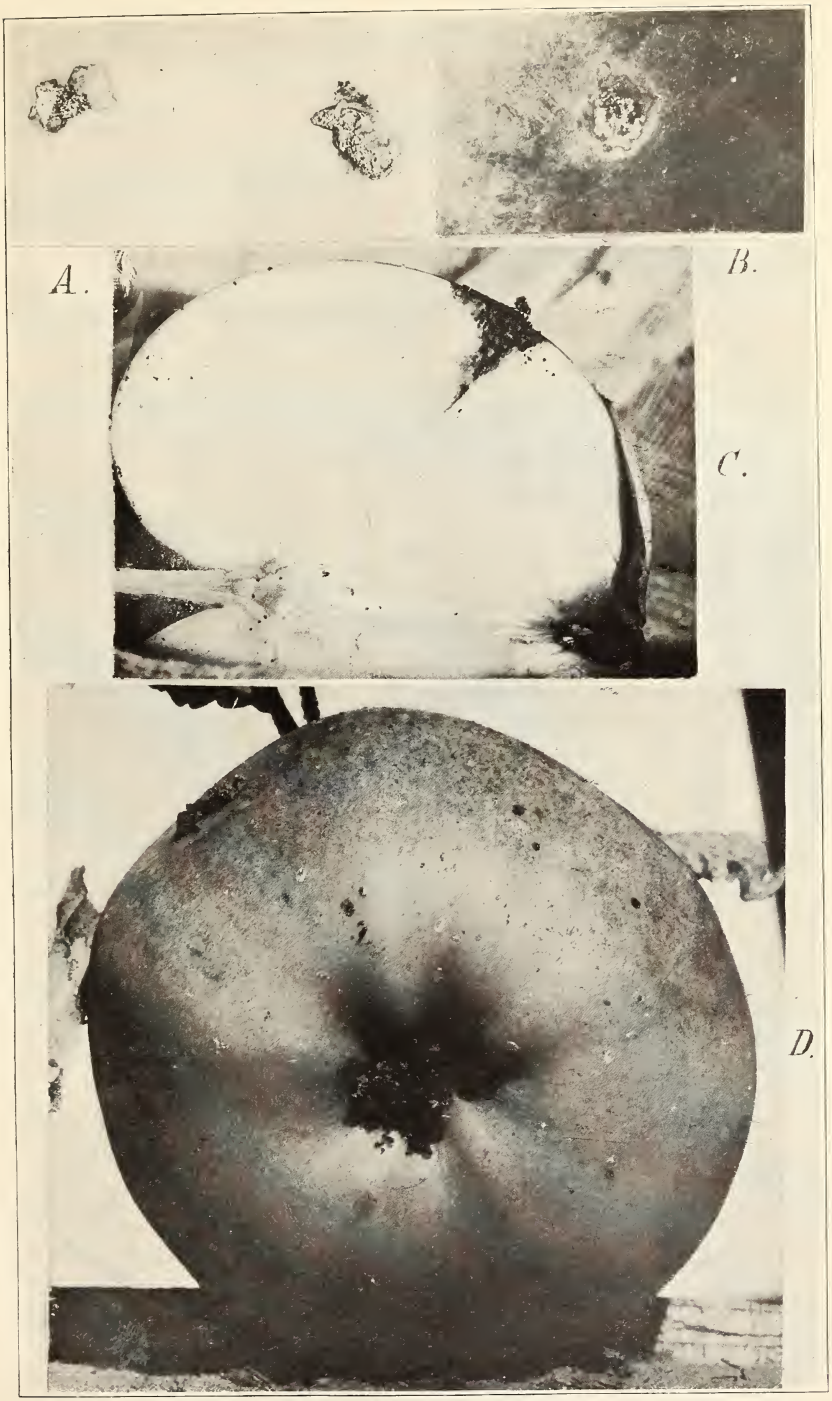
The effect of this insect on the apples and pears is such that they ripen prematurely and fall from the tree, being worthless for commercial purposes.

The larva makes its way from the apple to the place of spinning its cocoon in one of three ways. Most commonly it simply crawls from the apple to a twig, thence to branch, and thence to the trunk of a tree. Experiments conducted by Professor Aldrich upon trees with 5 bands show that twice as many larvæ spin their cocoons under the top band as under any intermediate band, and the next highest number was found under the bottom band. In case of windfalls, the larvæ leave the apple and crawl to a suitable place along the ground. In a few cases the larvæ drop from the tree to the ground by a silken thread. Many of these threads have been noted by the writer.

The larvæ spin their cocoons in a variety of places. Those noted are as follows: Under loose pieces of bark (Pl. III, fig. 2) on rough trees; in the cracks in the crotches of trees; in cracks or holes in the tree trunks; under splinters on fence posts (Pl. II, and fig. 1 of Pl. III); in the rough bark of adjacent trees (Pl. III, fig. 2); in any kind of rubbish about the trees; under anything lying against or upon the trees; in cracks in the dry earth about the trees; and, in some few cases, in dried fallen apples. The place of first choice under normal conditions is under the loose bark, in the crotches, or in the holes or cracks in the tree. When the tree is smooth and the earth is dry we sometimes find a considerable number of cocoons in the cracks in the earth.

In general the larva selects a dry, tight place, and it may gnaw out a hole in the bark and incorporate the pieces in the cocoon. Many times a silk tube 2 or 3 inches in length is found with a cocoon at one end. Evidently the larva did not find a place tight enough and continued spinning until such a place was made. In these cases a cap of silk is found. Cloth bands furnish a place for spinning cocoons most acceptable to the larvæ.

The larva spins its cocoon in about two days. The cocoon is composed of a single thread of silk, a product of the silk glands common



ENTRANCE HOLES OF LARVÆ.

FIG. 1.—BANDED TREE AND NEAR-BY FENCE.

FIG. 2.—POST OF FENCE SHOWN ABOVE, WITH SPLINTERS REMOVED.

FIG. 1.—PORTION OF FENCE POST, SHOWING OLD PUPA SKINS.

FIG. 2.—COCOONS IN CRACKS IN BARK.

to the larvæ of this order of insects. The cocoons of the early generation are fragile and not so heavy or well made as those of the later generation, in which the larva passes the winter.

THE PUPA.

The larva when spinning its cocoon is bent upon itself, but when the spinning is completed it straightens and becomes shorter and thicker. In about five days it sheds its last larval skin and becomes a pupa. One can always find this skin in a pellet at the caudal end of the pupa. The pupa is about half an inch long and at first is a pale yellow color, later becoming brown. The last day before the moth emerges it assumes a bronze color. The antennæ, mouth-parts, legs, and wings of the moth may be clearly seen, all soldered together in an immovable mass. The segments of the abdomen are movable and are armed on their caudal edge with spines which point backward.

Some time after the beginning of warm weather in the spring, or twenty-one or twenty-two days after commencing the spinning of the cocoon, in the summer, the moth emerges. The pupa pushes itself through the wall of the cocoon and out free from any obstruction. This is accomplished by rapid movement of the abdomen, aided by the spines which point backward. Pupæ were observed to have moved themselves fully an inch before a suitable place for emergence was found. They sometimes thrust themselves through muslin or burlap when such is used for bands and neglected. Soon after the pupa is free from the cocoon the pupa skin splits down the back and the moth slowly crawls out. Many experiments were carried out to determine the time elapsing between the spinning of the cocoon and the emergence of the moth. The shortest time was twelve days, and the longest during the summer was twenty-eight days, with an average of twenty-two. Only a very small percentage emerge the twelfth day.

THE MOTH.

Upon emerging the wings of the moth are small, the legs weak, and the body soft. The moth clings to the bark head up (Pl. IV, fig. 1), the wings gradually expand, and the legs and body harden and get stronger. Later the moth holds its wings for a few minutes above its back, like a butterfly. The wings are then replaced and the moth is ready for flight. During all these proceedings the moth carefully avoids the sunlight. After the wings are fully expanded and dry the moth frequently changes its position by running rapidly up the tree. In from ten to thirty minutes after emerging the moth usually flies to the lower branches of the tree and is lost as far as further observation is concerned. Quick, somewhat erratic flight is characteristic, the flight being so rapid that the eye can not follow it.

It is generally stated by writers on this insect that the adult is but rarely seen in orchards. During the summer of 1900 the writer saw only about half a dozen moths in the field. During the summer of 1901 from one to three were seen every day spent in orchards. These were usually on the fruit or on the upper surfaces of the leaves. On being disturbed they would flit away and be lost to sight.

But few fruit growers are familiar with the adult form of this insect. On this account many mistakes are made as to its identity. Anyone can easily confine larvæ or pupæ and in a short time settle the question of identity. The moth is quite variable in size, but never expands more than an inch. The wings at a glance have the appearance of watered silk, but upon closer examination one finds them crossed by numerous rows of gray and brown scales, which give the appearance of the plumage of a bird. Behind the tip of the forewing there is a large dark-brown spot which bears rows of bronze and gold-colored scales. The hind wings are of a light grayish color, darker toward the margin.

The sexes may be readily distinguished by the fact that the males bear a black pencil of hairs on the upper surface of the hind wing and a black spot on the under surface of the forewing.

Mr. Hitt, of Weiser, found in 1896 that of 50 moths but 7 were males. The writer found the females exceeding the males in number, but can give no figures.

During the summer of 1900 the writer found a moth on the trunk of a tree that had all the appearance of a codling moth except the color, which was buff and gold throughout, the bronze spot being much the same as in the codling moth. During the summer of 1901, 4 well preserved and 8 badly worn specimens having the same color were secured, and 2 others were observed in the field. Mr. Hitt, of Weiser, found 7 of these moths among 50 moths bred in 1896. Mr. McPherson has also noted this buff-colored moth. Whether this is a variety of *Carpocapsa pomonella* or another species has not yet been determined.

According to many observers the codling moth has been seen to feed upon the juice of ripe apples. Many fruit growers tell me that they have seen many moths about cider mills and have seen them feed on cider.

The conclusion arrived at by all investigators of this insect is that it is but little attracted to lights such as are used in trap lanterns. The writer finds, however, that moths will seek a window when they have emerged in a dark room or cellar.

In cages the egg laying begins the second day after emergence and has been observed to continue until the fourth day. In the field some eggs were observed to have been laid in the late afternoon and early evening.

The moths lay practically all of the eggs of the first generation upon the fruit, while those of the later generation are laid both upon the fruit and leaves. From many observations the writer is led to believe that there is no general rule as regards the eggs of the second generation. In some orchards the majority were found upon the fruit, and in others upon the leaves.

In cages the moths rarely live over a week.

GENERATIONS OF THE INSECT.

From the economic standpoint the number of generations is an important feature, as that is the chief factor in determining the amount of damage. In the Eastern States the generations vary from one and a partial second to two and a partial third. In California, Oregon, New Mexico, and Alabama, various investigators have published the statement that three generations occur. Professor Gillette has recently come to the conclusion that there are only two generations in Colorado. Professor Cordley says that there are only two at Corvallis, Oreg. In south Idaho, both Mr. McPherson and Mr. Hitt have advanced the idea that there are three full generations, and sometimes a partial fourth.

The writer has regarded this as one of the most essential points to be determined in the investigation of this insect. In 1900 an attempt was made to solve the problem. At the end of the season, though but little data had been secured, the conclusion was reached that there are three generations. The writer was not at all satisfied with this conclusion, and in 1901 considerable time was spent in studying this point.

Examination of the records of worms caught under bands showed that at certain periods greater numbers of worms went under bands than during the intervals between these times. By collecting and studying all available records it was found that these periods were quite constant, and this appears to be the best and most accurate way of determining the limits and number of generations.

In June, 1901, circular letters were sent to 60 fruit growers in different parts of the State of Idaho asking that records be kept of the larvæ killed under bands. But very few growers failed to answer. Among those who responded, a few stated that apples were not grown in their sections; others banded and found no larvæ or wormy apples; and still others could send no record on account of crop failure; but a large number sent in valuable records. These records were tabulated and curves have been drawn on cross-section paper.[a]

[a] It was the author's intention to include in the present report a number of charts showing these curves; but owing to incompleteness of preparation, and other circumstances, these charts have been reserved for publication in a later report.

L. O. H.

A summary of the more important records is here given:

Records of capture of codling-moth larvæ under bands.

Year.	Locality.	Observer or source of record.	Number of trees.	First maximum.	Second maximum.	Days between maxima.	Total number of worms.	Time between removal of bands.	Average per tree.
1897	Boise	Mr. Ayers	140	July 17	Sept. 1	46	12,247	Weekly	87.48
1898	do	do	140	July 10	Sept. 10	62	20,909	do	149.35
1899	Juliaetta	Prof. J. M. Aldrich.	40	July 20	Sept. 24	66	8,620	do	215.50
1901	Nampa	H. G. Gibson	4	July 26	Aug. 11	46	467	Daily	116.75
1901	Payette	J. Shearer	3	July 18	Aug. 17	60	215	Weekly	71.66
1901	do	do	80	July 1	Aug. 30	61	3,554	do	44.42
1901	do	do	128	July 5	do	56	1,690	do	13.2
1901	Provo, Utah	Utah Agricultural College.	23	do	Sept. 2	59	4,141	do	180
1901	do	do	26	July 13	Aug. 27	45	2,829	do	108.2
1901	do	do	34	July 5	Sept. 2	50	2,880	do	84.7
1901	Hagerman	R. E. Conner	27	July 12	Sept. 4	54	194	do	8.2
1901	Lewiston	S. G. Iasman	4	do	Sept. 10	60	666	6 per mo.	166.6
1901	Caldwell	Wm. C. George.	10	June 25	Aug. 13	49	640	2-5 days	64
	Total and average		659			55			

All of the records here given show plainly that there are but two maxima of larvæ entering bands. There are many sources of error in obtaining the figures. A maximum lasts from six to eight days. Weekly records are much more liable to error on account of the length of the intervals. The average length of time between maxima, fifty-five days, is undoubtedly too high, as the records of Mr. Gibson and Mr. George show the time to be forty-six and forty-nine days, respectively.

The writer has secured many other records, but they can not be relied upon for determining the number of generations, as some of them were taken on too few trees, and others commenced too late or stopped too early in the season.

The intervals between the maxima may be approximated in another way. From one maximum of larvæ entering bands to another should be the length of the life cycle of the insect. The length of the stages in the life of this insect vary greatly, and averages can be accurately determined only by a great number of experiments. The observations of the writer upon the length of the different stages are not so complete as could be wished, but will serve to show the averages approximately. The egg stage was found to vary from three to eight days, with an average of about five days. The life of the larva outside of the cocoon is from fourteen days to twenty-five days, averaging about twenty-one days. The time spent in the cocoon was found to be from twelve to twenty-eight days, averaging about twenty-two days. The egg-laying period was observed to begin the second day after the emergence of the moth and continue till the fourth day. Three days would probably be a good average. The total of these averages is fifty-one days, which time compares favorably with the interval between the maxima of larvæ entering bands.

FIG. 1.—PIECE OF BARK, SHOWING MOTH JUST EMERGED, AND OLD PUPA SKINS.

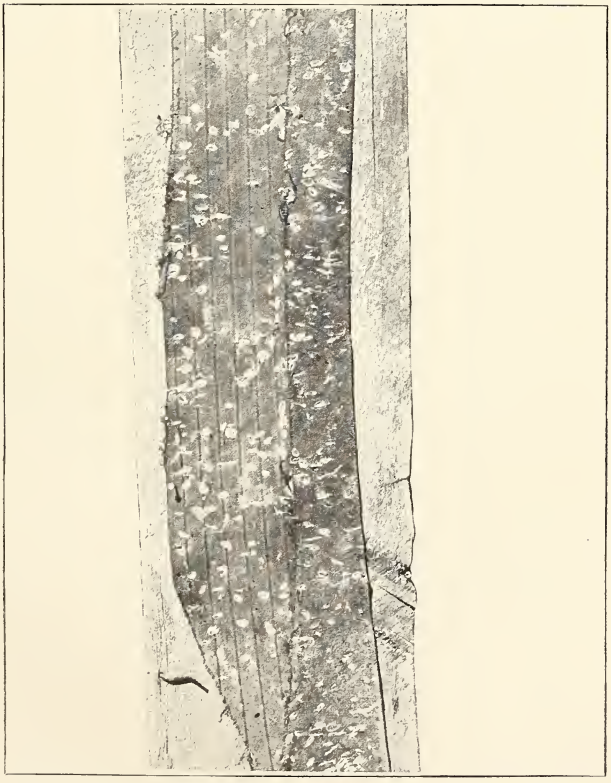


FIG. 2.—BAND ON WHICH THE REMAINS OF 330 COCOONS WERE COUNTED.

By adding fifty-five days to August 27 (the average time in 1901 of the maxima for the second generation), we should expect the maximum of the third generation entering bands. At that date (October 19) no such maximum appears upon the various records. It was noted in 1901 that none of the larvæ which spun cocoons after September 1 transformed, but all wintered as larvæ. In 1900 the corresponding date was September 7.

Mr. McPherson observed the period of the greatest number of eggs of the first generation to be from May 10 to May 25. The writer observed the same period of the second generation to be from about July 13 to August 4. But when the time came for the egg period of the third generation very few eggs were seen.

Observations were made daily in the orchards and the courses of these generations were watched as carefully as possible. On account of the variability of location of orchards and the overlapping of generations, observation is very liable to lead to error and can not be taken as proof except in so far as corroborated by other evidence.

It has been often noted that many young larvæ enter the apples in September. Whether these are the last of the second or the first of the third generation is a question which has puzzled the writer. But few of these new entrance holes were observed at Boise last September and October, and the writer is inclined to believe that the larvæ were the last of the second generation. If there was ever a full third generation, or a partial one, it should have occurred in 1901 by reason of the earliness of the season.

Professor Gillette's article on the generations of this insect has been carefully read. In general the writer's conclusions are the same, but they are based on data of a very different kind. The writer can not agree with Professor Gillette when he says that it is impossible for a partial third generation to be produced. A study of the life zones will show that we should expect some differences between the life history of the insect in Colorado and the same in Idaho.

The writer confesses that on many points there is a lack of data, and on this account does not wish to make the sweeping assertion that there are only two generations of the codling moth in southern Idaho. Whether or not there may be a partial third generation is still an open question and one which can be solved only by careful and accurate work. This much, however, is reasonably certain: The third generation is of little or no importance, whereas in the past it has been regarded as a full brood.

All future work will be based upon the assumption that there are two generations. It is hoped that next season's work will throw more light upon these doubtful points and fully establish the facts.

With the knowledge that there is no fourth brood and no full third

brood, the question of the control becomes easier for the Idaho fruit growers.

OVERLAPPING OF GENERATIONS.

The overlapping of the generations is one of the conditions which makes the control of the insect most difficult. In 1900, from July 7 to about September 7, the writer could find all stages of the insect. In 1901 about the same conditions were noted.

According to Mr. Hitt's experiments, the moths in the spring of 1896 emerged during twenty-three days.

The overlapping renders the spraying less effective than it would be if all the insects were in the same stage at the same time.

This overlapping is accounted for by the fact that some of the insects, being in favorable situations, grow more rapidly, and others, in unfavorable places, lag behind.

CAUSES AND CONDITIONS WHICH AFFECT THE NUMBERS OF THIS INSECT.

There are many natural conditions which tend to decrease the numbers of this insect in the Pacific northwest. Comparatively few of the eggs hatch. Infertility, excessive dryness, and the heat of the sun seem to be the causes of this. In 1901 thousands of the young larvæ must have starved on account of not having apples to feed upon.

No insect parasites were noted in 1901. A bird belonging to the creepers was noted at Payette. This bird was very active in hunting food on the apple trees, and without doubt destroyed many codling-moth larvæ. Growers in this locality say that the bird is increasing in numbers. Many pupæ were found to be dried and shrunken, evidently killed by excessive dryness. In more humid sections bacterial and fungus diseases kill many. But if these unfavorable conditions and natural enemies alone are relied upon, almost every apple in an orchard in badly infested localities will be wormy.

There are many reasons which may be assigned for the large number and the great destructiveness of the codling moth in Idaho. The first and probably the most important fact in this connection is that the second generation is more numerous than the first, and does a larger part of the injury. This is doubtless due to the climate. It is also more difficult to combat this second generation with sprays than it is the first. The overlapping of the generation is another fact that makes the spraying more difficult.

One reason for the great destructiveness of the codling moth in Idaho may be found in the life history of the insect. A great many of the fruit growers have used remedies which are absurd. When the proper remedies were used they were not used in the proper manner, and hence failure resulted.

Fig. 1.

Fig. 2.

Fig. 3.

VIEWS IN ORCHARD OF HON. EDGAR WILSON, SHOWING LOCATION OF APPLE HOUSE IN RELATION TO ORCHARD.

The absence of remedial measures, use of improper ones, and improper use of suitable remedies have resulted in the abundance of the insect, and have caused many to be discouraged and to have the firm belief that the insect can not be controlled.

The presence of old, neglected orchards is a source of constant supply of the insect, and these orchards render control more difficult.

PREVENTATIVE MEASURES EMPLOYED AGAINST THE CODLING MOTH.

There has been in the past an idea prevalent among the fruit growers of the Pacific northwest that the codling moth can be exterminated. That idea is at present held by only a few. The writer has always said that he believed it impracticable to entirely eradicate this insect from a large area. In an isolated orchard there are strong hopes that it can be done. Next season an attempt will be made to exterminate the insect in I. B. Perrine's orchard at Blue Lakes. This orchard is practically isolated and all methods will be used.

The very best general result that can be expected in Idaho is to control the insect so that its ravages will not exceed 10 per cent.

There are some localities in Idaho where the moth has not yet appeared. By keeping all infested fruit and old apple boxes away from these localities, immunity may be secured. In other localities at high altitudes sudden freezes will sometimes reduce the numbers of the insect to such an extent that it takes two or three years for it to again become injurious. Fruit growers in these localities should use the utmost vigilance, and, at the first appearance of the insect, remedies should be applied and the insect exterminated if possible.

When the wormy fruit is picked in the fall, it always contains larvæ in different stages. This fruit is stored and the insects complete their growth and spin their cocoons in the angles of the boxes and in cracks in the building. In the spring, immediately after emerging, the moths seek the nearest orchard. Where apples are stored in great quantity the fruit on the nearest trees is all damaged. Two well-marked cases of the results of storing apples were noted in Idaho in 1900. In both cases the apples growing nearest the apple house (Pl. V) were all wormy. In one case they were evidently infested in this way for about 5 rows toward the center and about 15 rows along the side of the orchard. In 1901 this place was still the place of worst infestation in one orchard. These conditions may easily be prevented by shipping the apples immediately after picking, and destroying the culls. If the fruit must be stored, the windows and holes of the storehouse should be screened. The moths will collect at these screens and may easily be crushed, or, if the house is so tight that they can not escape, they may be left to die.

Many fruit growers have committed a grave error in regard to the

crops of young orchards. The first crop is always small, and many do not think it worth while to use means against the moth for that season. The next season's crop is usually larger and always has a large percentage of wormy apples. If, however, the grower had destroyed most of the worms the previous season, the second crop would have suffered but little loss.

It has often been observed in Idaho that the apples in orchards in which the trees were irrigated by flooding were less wormy than those in orchards which are irrigated by ditches. Single trees or blocks of trees in ground that is continually moist bear less wormy fruit than those which are irrigated only occasionally. The only explanation offered for these facts is that the larva will not spin its cocoon in a moist place, and that moisture favors the diseases of the insect.

Whenever possible, the writer advises that the ground immediately around the trees be kept moist, especially when the larvæ are spinning their cocoons in greatest numbers. Care must be taken in doing this, as too much water will eventually either seriously injure or kill the trees.

The writer has noted many old, neglected orchards in various localities where no attempt was made to keep the insect in check. It needs no explanation that these orchards furnish a constant supply of moths to adjoining orchards, and in that way the loss in the orchard which is well cared for is greater than it would be if both received good care.

In towns and cities many people have in their lawns apple trees which also furnish a constant supply of the insects. These people wish the trees for shade only and have no desire to raise fruit. The writer has approached these people many times when the opportunity presented itself, and showed them what they could do to lessen the difficulty. The people who desire apple trees for shade only could easily destroy all the apples early in the season, and thus no damage would be done.

REMEDIAL MEASURES EMPLOYED AGAINST THE CODLING MOTH.

To intelligently apply remedial measures necessitates as a first essential an accurate knowledge of the life history of the insect. With this as a basis, any fruit grower may adapt the measures employed to his circumstances. It will readily be seen that there are certain periods in the life of this insect when it is vulnerable, and others when it is comparatively safe.

The few experiments which have been made against the insect show that it is impracticable to undertake the destruction of the eggs.

MEASURES AGAINST THE LARVÆ.

A large majority of all the remedial measures that have been used are against the insect in this stage.

Spraying.

Against the young larvæ entering the fruit, spraying with arsenical poisons is most generally used. The object is to place the poison in such places that when the young larvæ enter the apple they will get some of the poison with the first few meals.

EARLY SPRAYINGS.

The best time to spray is immediately after the blossoms fall and before the lobes of the calyx are closed. By spraying at this time the open calyx forms an excellent place to catch the poison, and by the closing of the lobes it is retained for some time. As before stated, from 80 to 85 per cent of the larvæ of the first generation enter by the calyx. Many cases might be cited showing the efficiency of this first spraying. One example will suffice: In the spring of 1901 the writer examined two orchards, separated only by a road. One had been sprayed thoroughly and other measures had been used; the other had not been sprayed, and no other measures had been used. From the first generation about 10 per cent of the apples in the sprayed orchard were wormy; in the unsprayed orchard 25 to 30 per cent were wormy. By count it was determined that in the unsprayed orchard 83 per cent of the wormy apples had been entered through the calyx, while in the sprayed orchard only about 10 per cent of the larvæ which entered by the calyx had escaped the poison.

On account of not being able to commence this work in the early spring, the writer was unable to make observations upon the hatching of the eggs of the first generation. Mr. Hitt furnishes the following data: In 1896 the first moths appeared May 5, and they continued to emerge until May 25. He also noted that the apple trees were in full bloom May 1. In 1901 the moths developed in advance of the blooming period.

Mr. McPherson noted the appearance of the first moths April 23, in 1901, and the first eggs May 10, which was about the time that the blossoms fell from the Winesap, Jonathan, Golden and Ben Davis varieties.

Investigators in different parts of the country have found that the poison stays in the calyx and is effective for at least a week; hence, the lateness of the moth offers no difficulty. Exactly what the moths do between the time of emerging and egg laying still remains to be studied in this locality. Professor Cordley has noted the same state of affairs in Oregon, and thinks that the cool nights prevent the moths from ovipositing.

The second spraying should be done about a week or ten days after the first. This spraying is intended for late larvæ of the first generation.

In cases of very bad infestation, or if extermination is aimed at, the writer would recommend a third spraying in this connection.

The writer has neglected no opportunity to impress upon the fruit growers of the Pacific Northwest that the first spraying is by far the most important remedial measure against this insect, and has gone so far as to state as his belief that one good spraying when the calyx is open saves more apples than all of the other remedial measures together.

LATER SPRAYINGS.

The question of late sprayings is one of the points now under discussion among entomologists and horticulturists. The facts gleaned from publications, letters, and conversations with those in the best position to know are as follows:

Professor Gillette, of Colorado, writes that in Colorado there are some fruit growers who advocate 9 or 10 sprayings, while others say that they obtain just as good results with 2 or 3. Professor Gillette says he has two cases in mind where as good results as one could wish were obtained with only 2 sprayings. He says he can hardly see how more than a slight benefit can be obtained by any spraying after the second.

Professor Card, in his Nebraska bulletin, rather discourages later sprayings.

Prof. M. V. Slingerland, in his bulletin upon this subject, states that he can not see how the larvæ get any of the poison from the side of the fruit.

Professor Washburn, of the Oregon station, concludes that 2 or 3 sprayings will save from 70 to 80 per cent of the early apples, and that 6 sprayings will save from 65 to 70 per cent of the winter apples.

Professor Cordley says that now he can obtain a much higher efficiency.

The writer visited the orchard of Olwell Bros., Centralpoint, Oreg., and estimated their loss in 1901 to be 5 per cent from the codling moth, and Mr. James Olwell told him that the loss was greater than in 1900. Many other apple growers in southern Oregon are obtaining similar results every year.

Mr. Gus Goeldner, of Boise, Idaho, writes that by spraying he saved 98 per cent of his apples, and Mr. C. Hinze, of Payette, Idaho, reported to the writer in 1900 that by spraying he had saved 95 per cent of his apples. Instances of such results, however, must be regarded as exceptional and may be deceptive, as account is probably not taken of the amount of fallen, wormy apples. It still remains to be proved exactly what percentage of apples can be saved by spraying alone in badly infested localities.

This question of later spraying has become one of the most impor-

tant features of the control of this insect. The writer has made many observations as to the efficiency of the spray. It is a common thing in sprayed orchards to find places on the apples where larvæ had entered and, a day or two after entering, had died. This condition was found to be much more frequent in sprayed orchards than in those which were unsprayed. Without doubt these larvæ were killed by the spraying. Exactly how and when the larvæ get the poison is a question. As has been stated before, the larvæ eat but little of the skin or flesh of the apple while entering. The cavities in which they are found dead are usually of such size that it would take the larvæ a day or two to make them. Particles of lime are sometimes found in these cavities. While seeking a place of entrance the larva may get some of the poison, and it may live a day or so after getting the fatal dose. Some of the spray may get into the entrance hole and be eaten.

Soon after dying, the larvæ become dry and shrunken and can be distinguished only by the presence of the head.

The writer once noted a case where 70 cent of the larvæ entering in the course of two or three days were found dead. It is extremely probable that a considerable part of them died naturally. Many other observations were made, but never was such efficiency noted again.

In many orchards that had been well sprayed, hundreds of these spots were noted which had been caused by the larvæ and upon examination no larvæ were found.

In 1901 the writer found a larva which had begun an entrance hole and had just died.

On account of these observations and the general results obtained by spraying and banding, the writer has no hesitancy in recommending these later sprayings. Without doubt the efficiency is much less than in case of the first spraying, but the writer believes them well worth the expense.

The writer has found that many growers spray when they have time and do not take into consideration the stage the insects are in. Some spray every three weeks and others spray when they see the number of entrance holes increasing. As already shown, the larvæ are entering more or less all summer; but at two certain periods of the season there are many more entering than at other times. One can easily see that the theoretically perfect time for spraying would be when the larvæ are entering the fruit in greatest numbers. It is therefore essential to recommend simple, practical methods for determining this period of greatest entrance. The writer advises every one who wishes to spray for the codling moth to keep a daily band record on about 4 trees. By a study of this record the maximum can be easily found. In the summer this maximum will be found sometimes between June 25 and July 15. By experiment we have found

that the maximum of egg hatching should occur twenty-nine days after the time when the greatest number of the preceding generation entered the bands. In the record made by Mr. Gibson it will be noted that the first maximum occurred June 26, and that by adding twenty-nine days we get the date of July 26. As the maximum of egg hatching extends over some time, spraying must be done before this date in order to get those which are early. In this instance the spraying should have been done between July 15 and August 4. Observation in the orchard in which the record was taken showed the period of greatest number of eggs to be between July 13 and August 4.

The writer has never had an opportunity to test this recommendation thoroughly. Many practical tests were made, and the results of these show that it is absolutely essential for highest efficiency to do the spraying when the largest number of larvæ are entering. The writer would advise two thorough sprayings during this period. Another may be made if infestation is bad.

MATERIAL FOR THE SPRAY.

It is recommended in every case that arsenical sprays be used for this work. Paris green is most used in the proportions of 1 pound to 160 gallons of water with 2 pounds of lime. By the use of this solution excellent results are secured, but on account of its cost and liability to settle many are abandoning it for the white arsenic compounds.

London purple is rarely used alone. Mr. Tiner, of Boise, and Olwell Brothers, of Centralpoint, Oreg., are using a combination of Paris green and London purple. Olwell Brothers use the following proportion: Water, 120 gallons; Paris green and London purple, 9 ounces each; and lime, 2 pounds. Mr. Tiner believes that in this way the poisons are kept in suspension better. Such good results are obtained that these growers are loth to adopt other compounds. White arsenic compounds are being used more and more with results just as good as those obtained with other arsenicals. Dr. H. P. Ustick, of Boise, and Mr. C. Hinze, of Payette, have used them successfully. Information as to the methods of making these sprays have been published in Idaho and the fruit growers are familiar with them.

As far as the writer can learn, lead arsenate has never been used as a spray against this insect in the Pacific northwest. The writer believes that it will be found excellent, and will use it in experiments next season. There are a few fruit growers who use whale-oil soap with the sodium arsenite. Many observations were made in connection with the use of this mixture to ascertain if it caused the poison to remain on the fruit longer. Without doubt this is the case, but the soapy solution collects on the under sides of the apples and damages

them materially. In one block of Jonathans fully 50 per cent of the clean apples had spots caused by the soap.

It is intended that future work will show exactly which one of these arsenites is the most effective.

EXPENSE OF SPRAYING.

From the data given by the fruit growers it is found that spraying is comparatively inexpensive. The material to spray 2,000 trees costs about $5. Orchardists always have teams and men already employed, so that the extra expense on account of spraying is very small compared with the benefit. By the use of a gasoline-power outfit the work can be done much more quickly, and, in a large orchard, with less expense in the end. When quickly done the cost should be less than 1 cent per tree per spraying. If inferior appliances are used, or the trees are larger than the average, the cost will be greater. Labor is the most expensive factor in spraying.

PICKING AND DESTROYING WORMY FRUIT.

While the larvæ are feeding in the apples, these may be picked and destroyed. This is especially recommended as an effective remedy for use early in the season. As has often been shown, thinning the apples to 4 inches apart produces a finer quality of fruit and causes the tree to bear well each year. It is strongly recommended that in Idaho, between June 1 and 15, the fruit be thinned, and that in thinning all wormy apples be removed and destroyed. The writer believes it well worth while to thin apples in order to kill the codling-moth larvæ, without considering the other advantages. Picking and destroying the wormy apples during July and August is too expensive to be of any great value in a large commercial orchard.

In order to get best results, orchards should be cleared of all windfalls as promptly as possible, so that the worms contained may be destroyed. In some small orchards it is the practice to allow hogs to run in the orchard and pick up the windfalls. It would be an almost endless and expensive undertaking to pick up and destroy the windfalls in a large orchard every day or two. The writer does not think it worth the expense if the proper precautions are taken in the use of the bands.

The cheapest and most effective way to get rid of culls, windfalls, and the apples picked in thinning is to bury them. Water should be allowed to run into the holes, and not less than 10 inches or a foot of earth should cover the fruit. If the earth is in clods, it will be well to pack it. Many observations were made during the season of 1901 to ascertain the effect of burying in this way. In many cases the larvæ succumbed to diseases induced by the moisture. Most of them spun

cocoons at the surface of the apples, but the moths were unable to escape. Larvæ put in the earth remain a longer time in the cocoon than they otherwise would.

Banding.

When the larvæ leave the apples and seek a place in which to spin their cocoons another point of attack may be taken advantage of by furnishing a suitable place for the spinning of the cocoons and by killing the worms after they have entered the place. This object is accomplished by placing cloth bands from 8 to 10 inches wide around the trunks of the trees. If the trees are large, each of the larger branches may also be banded. The bands may be made of any heavy fabric, such as burlap, old clothes, old carpet, etc. The band should be folded once lengthwise and placed around the trees about 1½ to 2 feet from the ground. After placing the band around the tree, a small nail should be driven through the ends firmly into the tree. The head of the nail should be nipped off. Subsequent removal and replacing of the bands may be done more quickly by this method of fastening.

The number of worms caught under these bands is sometimes astonishing. (Pl. IV, fig. 2.) It is quite common to find, during a maximum period, from 50 to 100 each week for two or three weeks under the band on a single large tree. The highest number Professor Aldrich records as caught on one tree from July 7 to October 15 is 494. Under neglected bands as many as 200 have been found at one time. It is found in orchards that have been sprayed and banded that, in September or the first part of October, the worms are very scarce, thus in a way showing the efficiency of the methods.

Apparently banding is one of the most effective methods, and there are two highly essential features that can not be emphasized too strongly: (1) All places suitable for spinning cocoons other than bands must be removed or rendered unsuitable. The loose bark should be scraped from the tree, all holes and cracks in the trees should be filled with mud or cement, and the earth around the trees should be kept moist during the periods when the worms are most numerous. (2) At regular intervals the bands must be examined and all the larvæ and pupæ killed. The interval between examinations of the bands recommended heretofore has been six or seven days. During the summer of 1901 the writer, by numerous experiments and observations, found that every ten or eleven days is often enough to kill the worms. This extension of time between the changing of the bands reduces the cost of banding considerably, as instead of 14 or 15 changes of bands there is need of only 10 or 11.

Many methods have been devised for killing the larvæ, but the most rapid and effective is either to crush them or cut them in two with a knife.

At the suggestion of Hon. Edgar Wilson the writer again experimented with Paris green in and under the bands to find whether or not the worms would get any of the poison and be killed. Five bands were thoroughly soaked in a strong solution of Paris green and a large quantity of the dry poison was dusted on 10 others. These were placed upon trees and examined every day or two. Not a single larva was found dead. Many were found to have spun their cocoons in the poison which was laying in the crotches of the trees.

Bands should be placed upon the trees not later than the middle of June and should not be finally removed until about a week after the crop has been harvested. By a close watch on a few bands one can tell when the worms begin to descend in the spring. After the first week in September it is found that very few, if any, larvæ change to pupæ and emerge. It is not advisable to let any bands stay on the trees all winter, as they rot, and the cost of bands is a considerable item in a large orchard.

Many fruit growers believe that under favorable circumstances they can save almost half their crop by banding alone.

It is strongly urged that, late in the fall, during the winter, or early in the spring, the orchard be examined, and all the larvæ found in crevices and under the bark of the trees killed.

MEASURES AGAINST THE ADULT.

TRAP LANTERNS.

Considerable effort has been made to put the facts about trap lanterns before the Idaho apple growers. The agent for a patented trap sold 240 in Boise and vicinity. He claimed that he caught 6 codling moths in one night. A majority of the growers who bought these traps found out for themselves that this method is useless. A very few still advocate its use. The writer did not think the method worthy of experiment.

BAITING THE MOTH.

One fruit grower at Mountainhome uses buckets of cider or vinegar, with which he says he catches large numbers of codling moths. Dr. Riley's experiences show that these catchings must have been accidental. The writer set out some of these cider buckets and in two weeks while the moths were flying caught but few. The notes on the experiment were misplaced, but the writer remembers that about 10 codling moths were caught and many Noctuids. At best the results of the method would in no way be commensurate with the expense.

RÉSUMÉ AND CONCLUSION.

As has been before stated, the codling moth can not be exterminated throughout the Pacific northwest. Reduction of the damage with

least expense has been the object in view. The writer believes that by the intelligent use of the methods herein given the moth can be so well controlled that the injuries will be between 2 and 10 per cent. With the insect under control, it will not be necessary to use all of these measures every year.

The writer has never had the opportunity of putting all of these recommendations into practice in one orchard. This would have been done had it not been for the freeze of 1901. Advice was given many times as to the treatment of orchards and the results were noted as far as possible. Some of the successes are here given:

M. A. Kurtz, Nampa, Idaho, has an orchard of about 2,500 trees, many of which are stunted partly on account of lack of care. In 1898 there was less than a full crop, about 50 per cent being damaged; in 1899 there was a full crop, but only 100 boxes of clean apples were harvested. In 1900 there was about one-fourth of a crop, and all were wormy. In 1901 Mr. Gibson, in charge, began good cultivation, spraying, and banding. There was probably over a half crop. The trees were all sprayed with Paris green four times, and a majority of them a fifth time. Bands were well attended to. The writer visited the orchard frequently during the season, the last visit being made the latter part of September, when the fruit was estimated to be damaged as follows: Ben Davis, 5 per cent; Steele's Winter Red, 10 per cent, and Blue Pearmain, 25 per cent. A few Ben Davis trees showed 10 per cent of damage. A large amount of the fruit was undersized. The writer could not get figures after the crop was harvested, but he believes the work done against the codling moth was quite successful. The only cause of uncertainty was the fact that the crop was small the year before, and the insect might possibly have been reduced on this account.

Hon. Edgar Wilson has an orchard (Pl. V) near Boise, containing about 4,000 trees, about 2,000 of which were bearing. There was a light crop of Jonathans and about one-half crop of Ben Davis. Only the early sprayings were made, and they were well done. Bands were well attended to. The later sprayings were not made, and the bulk of the injury was done by the second generation. Not over 40 per cent of the apples in this orchard were free from worms. In 1900 from 85 to 90 per cent were saved.

Mr. Tiner, of Boise, has about 400 trees, in a badly infested locality. Spraying and banding were well done, but only about 30 per cent of the fruit was saved. In 1900, 80 per cent was the amount saved.

The losses in many other well-treated orchards with small crops varied from 20 to 80 per cent. In those orchards where the loss was higher only partial measures were used. In untreated orchards in badly infested localities the loss was always about 100 per cent. The

reason of these excessive losses, even when the best measures were used, may be accounted for by the fact that the freeze killed a large percentage of the fruit, while the moths survived.

Olwell Brothers, of Oregon, spray every three weeks during the season, and the writer examined the orchard in October and estimated only 5 per cent loss from the codling moth.

The writer feels grateful to the Idaho growers for the way they have adopted his recommendations. Plans have been partially made for next season's work. In general, the plans are to select one or two typical badly infested orchards and there apply remedial and preventive measures to demonstrate exactly what can be done against the insect. The writer has no fears that the results will not substantiate all that is claimed for the remedial measures.

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